CHAPTER 15

Electric Energy and Circuits

CHAPTER CONTENTS

The massive conductors of a power transmission line carry huge currents at high potentials from power stations to your community. The hair-like lines on the printed circuit board in the photograph are the conductors that carry the microcurrents inside your computer and portable music system. Regardless of size, the conductors serve one purpose—to move electric energy, with minimal loss, to a device that will transform it into a desired form of energy.

To ensure that all communities have the electric energy they need, physicists and electrical engineers must know exactly how the properties of the conductor affect the current inside it. To design the circuit board for a computer, an electronic engineer must know how resistance can be used to control the amount of current to the branches of the circuit, so that each computer component gets the correct amount of current at the correct voltage.

In this chapter, you will develop an understanding of how and why electric circuits behave as they do. You will revisit the relationships among potential difference, current, and resistance. You will learn how to diagram, connect, and analyze complex electric circuits to learn how much energy is available to each of the circuits' loads.

INVESTIGATION 15-A

Potential Differences along Current-Carrying Conductors

TARGET SKILLS

- Manipulating and recording
- Analyzing and interpreting
- Communicating results

Have you ever wondered why birds can sit on bare, high voltage power lines without being electrocuted? After you have completed this lab, you should be able to explain why birds seem unaffected by the current in the wire.

Potential difference (or voltage) is a measure of the electrical effort that is being exerted on a system. If a voltage exists between two points on a conductor then a current will flow between those points.

Problem

On a current-carrying conductor, how does the potential difference between two points on the conductor vary with length between the points?

Equipment

- power supply
- voltmeter
- metre stick
- thumbtacks
- Nichrome™ wire (22 gauge)
- insulated conductors with alligator clips

Procedure

1. Connect the apparatus as shown in the diagram.
2. Attach the leads from the voltmeter to the wire near the opposite ends of the metre stick. Have your teacher confirm that the voltmeter is connected correctly.
3. Increase the voltage from the power supply until the voltmeter reads about 2.5 V. Record the length of wire between the clips and the voltmeter reading in a data table.

CAUTION As long as you touch the alligator clips with only one hand you can move them along the wire with no danger of shock.

4. Without adjusting the power supply, move one alligator clip along the wire about 15 cm closer to the other and record the length between the clips and the voltmeter reading. Repeat until the length between the clips is zero.
5. Plot a graph of the line of best fit for voltage versus length between clips.

Analyze and Conclude

1. What does the graph tell you about the relationship between voltage and length between clips?
2. In light of your findings, explain why birds are not electrocuted when they sit on bare power lines.

Apply and Extend

3. How is the voltage affected if you move both clips along the wire keeping them a constant distance (say, 15 cm) apart?
4. Does increasing the voltage affect the nature of the result? Try the experiment with the voltage set at 4.0 V.